

NAME P/N QTY	CRIT	FAILURE MODE & CAUSES	FAILURE EFFECT	RATIONALE FOR ACCEPTANCE
PRESSURE BOOT ASSEMBLY, ITEM 104 (1) LEFT (1) RIGHT ----- 0104-210895- 25/26/29/30; 0104-210895- 33/34/35/36 (2)	2/1RB	104FM35 Loss of fabric restraint. Separation of seam or hole in restraint fabric. Defective thread or fabric.	END ITEM: Opening in fabric restraint exposing bladder. Loss of restraint circumferential load carrying capability. GFE INTERFACE: Loss of bladder protection. Bladder exposed to TMG. Loading and abrading of bladder. MISSION: None. CREW/VEHICLE: None with single failure. Loss of crewman with loss of bladder. TIME TO EFFECT /ACTIONS: N/A TIME AVAILABLE: N/A TIME REQUIRED: N/A REDUNDANCY SCREENS: A-PASS B-FAIL C-PASS	A. Design - The restraint is fabricated from 6.4 ounce dacron fabric which exhibits a minimum tensile strength of 300 lbs. (warp) and 250 lbs. (fill). Material strength is 20 (fill) to 24 (warp) times greater than the hoop load of 12.5 lbs. predicted at normal operating pressure (4.4 psid). At 5.5 psid (max failure pressure) the material strength is 15.8 (fill) to 19 (warp) times greater than the hoop load of 15.8 lbs. At 8.8 psid (max BTA operating pressure, the material strength is 9.9 (fill) to 11.9 (warp) times greater than the hoop load of 25.3 lbs. The basic seam employed in boot restraint construction is one row of join stitching and two rows of top stitching. Seams are formed using size "F" polyester thread per V-T-28D type II, class I with a lock stitch type 301 per FED-STD-751A. Seams are terminated by backtacking and searing of thread ends. Seam strength, as determined by testing, is equal to or better than the restraint material. A TMG serves to protect the restraint fabric and stitching from abrasion and puncture. The boot bladder assembly is formed from a series of patterned pieces of urethane coated nylon oxford fabric, seamed together by dielectric heat, to which flanges are also heat sealed. The bladder seams and flanges are reinforced by heat sealed overtaping to enhance structural integrity. The solution coated bladder is protected internally by an additional heat sealed abrasion layer. There are two types of bladder fabric. One is constructed of a base nylon fabric with a solution coated urethane. The other is constructed of the same base nylon with a urethane laminate coating. The following paragraph applies to the solution coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 105 lbs/inch (fill) and 140 lbs/inch (warp) and 3.5 lbs/inch in fill and 6.0 lbs/inch in warp, tearing strength. The bladder fabric is aligned with the warp parallel to the hoop load that would be sustained by the bladder in the event of a restraint fabric failure. Based on a predicted hoop load of 12.7 lbs, the minimum safety factor for hoop stress is 11.0 at 4.4 psid (normal operating pressure). At 5.5 psid (maximum failure pressure) the predicted hoop load is 15.8 lbs with a safety factor for hoop stress of 8.8. At 8.8 psid (maximum BTA operating pressure) the predicted hoop load is 25.3 lbs with a safety factor for hoop stress of 5.5. Testing has demonstrated that the tensile strength of the bladder seams meets or exceeds that of the bladder fabric. The following paragraph applies to the laminate coated nylon. Testing has shown that the bladder fabric minimum tensile strength is 170 lbs/inch (fill) and 180 lbs/inch (warp) and 3.5 lbs/inch minimum. The bladder fabric is aligned with the warp parallel to the hoop load that would be sustained by the bladder in the event of a restraint fabric failure. Based on predicted hoop load of 12.7 lbs, the minimum safety factor for hoop stress is 14.2 at 4.4 psid (normal operating pressure). At 5.5 psid (maximum failure pressure) the predicted hoop load is 15.8 lbs with a safety factor for hoop stress of 11.3. At 8.8 psid (maximum BTA

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operating pressure) the predicted hoop load is 25.3 lbs with a safety factor for hoop stress of 7.1. Testing has demonstrated that the tensile strength of the bladder seams meets or exceeds that of the bladder fabric.

B. Test -
Acceptance:
Components - see inspection.

PDA:
The following test is conducted at the boot level in accordance with ILC Document 0111-710112:
Proof pressure test at 8.0 + 0.2 - 0.0 psig for a minimum of 5 minutes conducted with the TMG removed.

Certification:
The Enhanced Boot restraint was successfully tested (manned) during certification to duplicate operational life (Ref ILC Doc. 0111-711330).

The following usage, reflecting requirements of significance to the boot restraint was documented during certification:

Requirement	S/AD	Actual
Ankle Flexion/Extension	11614	24000
Walking Steps	4320	77760
Pressure Cycles	300	600
Don/Doff	98	400
Pressure Hours	458	916

The Enhanced Boot restraint was successfully subjected to a BTA ultimate pressure of 13.2 psig. (1.5 times max BTA operating pressure based on 8.8 psig). (Ref. ILC Doc. 0111-711330).

C. Inspection -
Components and material manufactured to ILC requirements at an approved supplier are documented from procurement through shipping by the supplier. ILC incoming receiving inspection verifies that the materials received are as identified in the procurement documents, that no damage has occurred during shipment and that supplier certifications have been received which provide traceability information.

MIP's are performed for inspection of sewn seams during the boot restraint manufacturing process to assure that this particular failure cause is precluded from the fabricated item.

During PDA, the following inspection points are performed at the boot assembly level in accordance with ILC Document 0111-710112:

1. Visual inspection for fabric or material degradation. Seams are inspected for broken or frayed stitches.
2. Visual inspection for structural damage following proof pressure test with

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		104FM35		<p>TMGs removed.</p> <p>D. Failure History - None.</p> <p>E. Ground Turnaround - None, for every component within its limited life requirements.</p> <p>Every four years or 229 hours of manned pressurized time the boot restraint and bladder assembly is separated from the LTA and subjected to a complete visual inspection (Interior and Exterior surfaces) for material damage and degradation. Following reassembly to the LTA, structural and leakage tests are performed.</p> <p>F. Operational Use - Crew Response - Pre/post-EVA : No response, single failure not detectable. EVA : No response, single failure not detectable. Special Training - No training specifically covers this failure mode. Operational Considerations - Not applicable.</p>

EXTRAVEHICULAR MOBILITY UNIT
SYSTEMS SAFETY REVIEW PANEL REVIEW
FOR THE
I-104 LOWER TORSO ASSEMBLY (LTA)
CRITICAL ITEM LIST (CIL)

EMU CONTRACT NO. NAS 9-97150

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